

SYLLABUS 2018/2019

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| Level of study | Master's Course | | |
| Course title in Ukraine | Практикум з радіоспектроскопії | | |
| Course title in English | Practical training of radiospectroscopy | | |
| Course code | | ECTS credits | 3 |
| Lecturer(s) | Dr.Sci., prof. Kovalenko A.V. Email address: fttkaf@i.ua | | |

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| Course objectives (learning outcomes) | <p>This course aims to provide an introduction to the basic ideas and major topics in radiospectroscopy of solids.</p> <p>The students will learn the basics of magnetic resonance phenomena, fundamentals of EPR and NMR spectroscopy, spin Hamiltonian formalism for description of magnetic resonance spectra in condensed matter systems, practical use of radiospectroscopical methods (EPR, NMR, NQR) in various fields of science and technology.</p> |
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Prerequisites:

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| Knowledge | Knowledge of mathematics and physics on the level of bachelor in physics or applied physics |
| Skills | Mathematical and physical skills on the level of bachelor in physics or applied physics |
| Courses completed | The bachelor in physics or applied physics. |

Learning effects:

| | Learning effects of the course | Relation of the learning effects to the specialization |
|-----------|--|--|
| Knowledge | <p>W01 A student has a basic knowledge in general and quantum mechanic physics.</p> <p>W02 A student understands foundations of magnetic phenomena in solids.</p> <p>W03 A student comprehends physical principles of basic radiospectroscopical methods and mathematical approach for analysis the experimental data.</p> <p>W04 A student knows the structural schemes and principles of conventional radiospectrometer operating.</p> | W01 – W10 |

| | Learning effects of the course | Relation of the learning effects to the specialization |
|--------|---|--|
| Skills | <p>U01 A student is able to use mathematical tools of quantum mechanics to describe the resonance phenomena in the ensemble of magnetic moments.</p> <p>U02 A student is able to perform a description of the magnetic spectra in solids on the basis of the spin Hamiltonian method.</p> <p>U03 A student understands and can use spin Hamiltonian formalism to describe fine, hyperfine and superhyperfine structures of EPR spectra.</p> <p>U04 A student is able to use radiospectroscopic methods, to realize abilities of EPR technique in the study of solids.</p> | U01 – U07 |

| | Learning effects of the course | Relation of the learning effects to the specialization |
|--|--|--|
| | K01. A student has the creativity and the ability to conceptual thinking. K02 A student is able to present and justify the personal point of view. K03 A student is able to use the information technologies for the communication with the scientific community. K04 A student is aimed to expand personal knowledge and skills. K05 A student has the legal erudition. K06 A student concerned about the environmental safety of physical experiment. | K01 – K06 |

Course organization:

| Form of classes | Lecture (W) | Group-exercises | | | | | | | |
|-----------------|--------------------|-----------------|-----------------|--|---------|--|-------------|-------------|-----------|
| | | A (large group) | K (small group) | | L (Lab) | | S (Seminar) | P (Project) | T. (Test) |
| Contact hours | | | | | 28 | | | | 1 |
| Semester | 2 | | | | | | | | |
| Language | English, Ukrainian | | | | | | | | |

Teaching methods:

Classes will be performed in tutorial system on a weekly basis using multimedia presentation and internet in a form of the lectures open for discussion and questions.
 In-class exercises are designed to probe knowledge developed through this process, with emphasis on how well students have understood the underlying mathematical and physical ideas.
 The students will prepare one individual presentation.

Assessment methods:

| | E – learning | Didactic games | Classes in schools | Field classes | Laboratory tasks | Individual project | Group project | Discussion participation | Student's presentation | assignment (essay) | Oral exam | Written exam | Test |
|-----|--------------|----------------|--------------------|---------------|------------------|--------------------|---------------|--------------------------|------------------------|--------------------|-----------|--------------|------|
| W01 | | | | | | x | | x | | | | | x |
| W02 | | | | | | x | | x | | | | | x |
| W03 | | | | | | x | | x | | | | | x |
| W04 | | | | | | x | | x | x | | | | x |
| U01 | | | | | | | x | x | | | | | x |
| U02 | | | | | | | x | x | | | | | x |
| U03 | | | | | | | x | x | | | | | x |

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| U04 | | | | | | | x | x | | | | | x |
| K01 | | | | | | x | | x | x | | | | x |
| K02 | | | | | | | x | x | | | | | x |
| K03 | | | | | | | x | x | x | | | | x |
| K04 | | | | | | x | x | x | | | | | x |
| K05 | | | | | | | | | | | | | x |
| K06 | | | | | | | | | | | | | x |

Assessment criteria:

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| Grades | <p>The grading scale will be as follows:</p> <p>90 – 100 % - A including A- excellent (eq. in Ukraine: відмінно (very good))</p> <p>82–89 % : B including B – very good (eq. in Ukraine: добре (good))</p> <p>74–81 %: C including C – good (eq. in Ukraine: добре (good))</p> <p>64–73 %: D including D – satisfactory (eq. in Ukraine: задовільно (satisfactory))</p> <p>60–63 %: E including E – acceptable (eq. in Ukraine: задовільно (satisfactory))</p> <p>< 59 %: F failed (eq. in Ukraine: незадовільно (unsatisfactory))</p> |
| Criteria | <p>A. A student knows all terms and concepts mentioned in W1-W4, U1- U4 and K1-K4. A student can work without any assistances, his/her knowledge's are creative and easily applied to decision of specific problem.</p> <p>B. A student knows all terms and concepts mentioned in W1-W4, U1- U4 and K1-K4, yet needs a little help when decision of specific problem.</p> <p>C. A student knows all terms and concepts mentioned in W1-W4, U1- U4 and K1-K4, however needs a help when decision of specific problem.</p> <p>D. A student knows the most of terms and concepts mentioned in W1-W4, U1- U4 and K1-K4 and has difficulty in decision of specific problem.</p> <p>E. A student knows only several terms and concepts mentioned in W1-W4, U1- U4 and K1-K4 and can solve only a simple problem.</p> <p>F. A student does not know most of terms and concepts mentioned in W1-W4, he/she did not reach the satisfactory level of knowledge this course.</p> |

Course content (topic list):

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| Topics | <p>1. Basics of physics of magnetic phenomena in solids.</p> <p>W1. Some basic concepts of magnetism.</p> <p>W2. Basic information on the magnetic moments of the electron shell of atom.</p> <p>2. Paramagnetic Resonance.</p> <p>W3. Quantum mechanical description.</p> <p>W4. The classic description.</p> <p>3. Electron paramagnetic resonance in solids.</p> <p>W5. Influence of crystal field. The fine structure of EPR spectra.</p> <p>W6. The interaction of electron spin with nuclear one. Hyperfine structure of EPR spectra.</p> <p>W7. The interaction of the electronic spin with the nuclei of ligands.</p> <p>Superhyperfine structure of EPR spectra.</p> <p>4. Spin Hamiltonian formalism.</p> <p>W8. Magnetic properties of ions in crystals.</p> <p>W9. Hamiltonian of the magnetic ion.</p> <p>W10. The method of spin Hamiltonian.</p> <p>5. Spin Hamiltonian and EPR Spectra.</p> <p>W11. Anisotropy of the spectroscopic splitting g- factor in crystalline systems.</p> <p>W12. Anisotropy of hyperfine interaction in crystalline systems.</p> |
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Literature:

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| Compulsory reading | <ol style="list-style-type: none"> 1. Abragam, B. Bleaney, Electron Paramagnetic Resonance of Transition Ions, Clarendon, Oxford, U.K., 1970. 2. Abragam, The Principles of Nuclear Magnetism, Clarendon, Oxford, U.K., 1961. 3. Wertz JE, Bolton JR. Electron Spin Resonance: Elementary Theory and Practical Applications. London: Chapman and Hall; 1986. 4. Weil, J.A., Bolton, J.R., Wertz, J.E. (1994) Electron Paramagnetic Resonance, Elementary Theory and Practical Applications, Wiley-Interscience, New York. 5. Weil JA, Bolton JR. Electron Paramagnetic Resonance: Elementary Theory and Practical Applications. 2nd Edition. New York: John Wiley & Sons; 2007, 664 p. |
| Recommended reading | <ol style="list-style-type: none"> 6. M. Zdybel and B.Pilawa. Application of Electron Paramagnetic Resonance Spectroscopy in Ophthalmology (http://dx.doi.org/10.5772/58313). Published by ITECH, 2013, 88 p. 7. Stankowski J, Hilczer W. Wstęp do spektroskopii rezonansów magnetycznych. Warszawa: PWN; 2005. 8. Symons M. Spektroskopia EPR w chemii i biochemii. Warszawa: PWN; 1987. 9. Kirmse R, Stach J. Spektroskopia EPR. Zastosowania w chemii. Kraków: Uniwersytet Jagielloński; 1994. |

Estimation of the total working time of students:

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| Contact hours | Lectures | 28 |
| | Seminars | |
| | Other (consultation, meetings) | 14 |
| Students' work hours (without the lecturer) | Reading books and preparation for the lectures | 10 |
| | Preparation to the seminar | |
| | Preparation of an individual presentation | 15 |
| | Preparation to the test | 10 |
| Total works' hours | | 75 |
| ECTS credits 1 ECTS = 25 h | | 3 |